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ECONOMIC COORDINATION OF PRIVATE TRUCK FLEETS
WITH ADDITIONAL PURCHASED TRANSPORTATION
FOR TRANSFER OF INTERCITY FREIGHT

A THESIS

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ABSTRACT

ECONOMIC COORDINATION OF PRIVATE TRUCK FLEETS
WITH ADDITIONAL PURCHASED TRANSPORTATION
FOR TRANSFER OF INTERCITY FREIGHT
(63 pages)

By James Malcolm Fiveash

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The amount of intercity freight which private carriers have ready for shipment seldom exactly equals the capacity of the trucks which are available at a specific time. When the freight to be shipped exceeds the truck capacity, some shipments can be offered to common carriers. This thesis presents quantitative aids to the determination of the shipments which should be routed by common carriers and the shipments which should be transferred on the company's vehicles.

An analytical and graphical investigation of common-carrier transportation costs is made showing the relationships between these costs and shipment weight and distance. The fixed, semi-fixed, and variable costs of operating a truck fleet provide the basis for the determination of the equivalent freight rates and total shipment costs for private carrier operation.

A type of "transportation break-even chart" is developed which shows the difference between the cost of private-fleet transportation and the costs of common-carrier transportation for various shipment weights and distances. The term "private fleet gain" is used to

designate a condition in which the private fleet costs are less than the common-carrier transportation costs, and "public transportation gain" denotes a situation in which the private fleet costs exceed the public transportation costs. Using these costs in the profit and loss sense, manufacturing economic principles and theories are applied to the transportation problem. The application of break-even charts, economic dumping practices, multiple-pricing theory, expense-output relationships, and manufacturing capacity analysis to the operation of a private fleet of trucks in coordination and competition with additional purchased transportation services is discussed.

The various factors which affect the expense functions of the private fleet and the transportation charges for common-carrier services are presented, and the manner in which these factors influence the private fleet gain is given by graphical analysis. These graphical analyses provide the basis for determining the shipments which result in the greatest savings when routed by the private fleet.

CHAPTER I

INTRODUCTION

The efficient, well-organized management of the modern industrial enterprise requires the correct, balanced blend of the ingredients of production. These elements of production--land, labor, materials, and capital--can only be placed in a position of worth to industry with the application of transportation methods. The net result of manufacturing effort, the finished product, requires the services of freight transportation to place the article within reach of the consumer.

Although it adds nothing to the intrinsic value of the product, the transportation service increases the worth of the goods by placing them in a position needed for additional manufacturing processing or consumer markets. Consider, for example, the relative worth of a bumper crop of oranges packed and ready for shipment near the Florida groves and the value of the same oranges spread over the consumer markets in the Northeastern and Middle Western areas of the United States. The movement of the fruit from a place where it is so abundant that it has no value to areas where it is scarce created a place utility for the goods. The same type of increase in the value of raw materials results from the utility that is obtained when the materials are moved from the natural locations of these resources to manufacturing centers.

The use of the transportation network of the United States has resulted in nationwide marketing of products. The advent of these nationwide markets has given rise to the manufacture of additional products

which could not have been sold with sufficient volume in regional or local markets. This wide-scale merchandising allows the manufacturer to increase the total volume of production, obtain further division of labor, and thereby decrease the unit cost of manufacture.

Further evidence of the importance of freight transportation facilities to American industry is given in the magnitude of the percentage of the selling price of goods which results from transportation charges. The Chamber of Commerce of the United States¹ estimates that, on the average, freight charges are ten per cent of the selling cost of a product. Since the value to the company of the dollar spent for transfer of freight does not differ from the value of the dollar allotted to the salary of the general manager, cost of electrical power, or for the purchase of raw materials, the interest in transportation should be tantamount to the interest that management has shown in other cost factors of production and distribution.

In recent years the management of industrial organizations has been prodded into taking a more complete interest in transportation due to several pressing factors. The most important of these reasons for examining the industrial freight bill is the continuing increases in freight rates of purchased transportation. Cushman² states that "since the end of World War II, carrier rates have shown an average increase of well over 60 per cent". Granted that other production costs have also

¹"Transportation in Distribution," Steel 135:90, August, 1954.

²Frank M. Cushman, Transportation for Management (New York: Prentice-Hall, Inc., 1953), p. 63.

been increasing during this period, but the increases in transportation charges should still be considered noteworthy. However, the analysis of freight charges which is necessary to show the relationship between general rates increases and the total cost of a particular company's product has been curtailed by the accounting practice of combining all distribution costs into a single category, cost of sales. Only since the recent growth of the profession of industrial traffic management has the proper control and evaluation of transportation freight costs been effected in industry. Some writers such as Tomlin³ and Potter⁴ feel that the major emphasis in cost reduction techniques during the past 50 years has been placed on the manufacturing aspects of the industrial enterprise, and they contend that having relatively depleted the possibilities in that area, the remaining spot where sizable savings can be made is in the field of distribution. The same type of scientific, engineering analysis that has raised manufacturing to present-day efficiency must also be applied to the field of freight transportation.

The increasing cost of for-hire transportation has turned the attention of management toward another form of freight service--the private carrier. In this case the freight is not offered to a common carrier or a contract carrier for transfer but is moved on trucks either owned or leased by the shipper or consignee. This interest in private fleets,

³Stokes Tomlin, "Future Cuts in Cost Will Come Largely From Better Distribution, Oil Man Says," National Petroleum News 42:34, February, 1950.

⁴Joseph C. Potter, "New Dimensions in Distribution," Magazine of Wall Street 96:796, September, 1955.

caused by a desire to decrease costs, is implemented by an equally pressing desire to improve customer delivery service. With total control over the movement of the freight from the fleet-owner's door to his customer's door, faster, more accurately-scheduled shipments can be offered. However, the operation of private fleets has the disadvantage of not being fully adaptable to all situations; this point will be pursued further in later chapters.

Before 1951, when the United States Supreme Court ruled on the Brooks Transportation Company case, the management of industrial concerns was wary about assuming the high initial costs of acquiring equipment for the transfer of their own freight. The relationship between the regulatory powers of the Interstate Commerce Commission and the private nature of the company-owned fleets of trucks was not clearly defined, and it was not known if the ownership of the fleets would be profitable under the regulation of the government body. Representatives of common carriers were actually operating in the manner of for-hire carriers when the owner added an additional sum to the net price of the goods for providing intercity delivery service. However, as Cushman observes, the Brooks Transportation decision

...effectively permits the operator of the vehicles to assess charges that will adequately--if not more than adequately--cover the cost of fleet operation. Furthermore, the private carrier requires no authority to operate under the Interstate Commerce Act or the various state public-utility regulations and consequently may send trucks anywhere in the nation....⁵

The functions and responsibilities of the industrial traffic department are many and varied. The traffic manager may concern himself

⁵Cushman, op. cit., p. 64.

with management functions such as analysis of transportation services and rates by the various types of transportation available, planning storage and warehouse facilities, the study of transportation legislation, study of various distribution patterns, and rate negotiations by regulating bodies. His staff may, at the same time, perform routine or clerical duties such as auditing freight bills, routing shipments, expediting and tracing shipments, and preparation of claims.

It is not the purpose of this study to analyze the operation of an entire traffic department, but the objective is to treat fully one aspect of the management of industrial freight movement--the operation of the traffic department in the role of a private carrier. The purchase of a fleet of trucks requires a large expenditure of capital for a company, and management wants to have correct, quantitative methods of determining before the purchase if the transfer of freight by the company's trucks is going to result in a significant savings over the cost of shipping entirely by common carriers. Management also desires to have the optimum number of trucks in the fleet in order to obtain the greatest possible savings. It would not be wise to procure enough trucks to haul all of the company's freight, for at times, due to inevitable random fluctuations and normal periodic oscillations, some of the fleet would have to be idle, and too, not all of the freight would necessarily be moved more cheaply by the private fleet. It therefore becomes necessary for the company to purchase enough trucks to handle only a "certain percentage" of its freight and to offer the remaining freight to common carriers. The question which then arises is, "Which shipments should we route by common carriers and which should move by our own trucks?" The question may immediately be answered by a curt

statement such as, "We will naturally send the shipments on which we obtain the most savings by our own trucks and route the remaining shipments which give loss or little savings (when shipped by the fleet) by the common carrier."

This type of analysis shows proper reasoning, but the question is still only half answered. It is still necessary to know under what conditions shipments result in lower costs by private fleets and what factors affect these costs. The purpose of this thesis is to develop and present graphic and analytical aids for obtaining answers to this question. Common-carrier freight costs and the expense of private-fleet freight will be analyzed, and an analogy to manufacturing economics will be used to develop methods for determining the differences in these costs.

In attempting this study certain assumptions and limitations need to be made. First, the type of freight which will be discussed is "non-premium" freight, or in other words, freight which does not need fast service and which does not place the private fleet in competition with the air freight or air express service. Secondly, the freight will be assumed to be in rather large lots--large enough so that the private carrier is not in competition with railway express or parcel post for its transfer. Due to its limited geographical coverage the water freight system will arbitrarily be omitted in the specific examples and discussion given in the thesis, but the principles which are discussed could just as well apply to the coordination of private fleets with this transportation medium. The term "common carrier" in this volume shall therefore be construed to be limited to only rail carriers and motor freight carriers.

Before beginning the study, a systematic search of the literature of the transportation field was made. The search included both books and periodicals, but mention of private fleet operation in the literature was found to be scarce. In fact, out of the few references to private fleets only one writer touched on the specific subject of this thesis. Wilson hinted at the statement of the problem of this study by stating:

The most important function of the traffic department in connection with motor transportation is the correlation of motor with other transportation services. The traffic department must decide what portion of the through transportation service is to be performed by trucks and the portion to be performed by other instrumentalities.⁶

Because of this general lack of published background material on the subject of this thesis, a rather detailed explanation of terms and procedures used in the transportation field will be given in Chapter II and Chapter III.

⁶G. Lloyd Wilson, Traffic Management (Englewood Cliffs: Prentice-Hall, Inc., 1953), p. 119.

CHAPTER II

DETERMINATION OF PURCHASED TRANSPORTATION PRICES

Before turning to a comparative analysis of purchased transportation costs and private-carrier transportation costs, it is advisable to examine the methods, procedures, and factors involved in obtaining these cost relationships. A complete understanding of the common-carrier rate structure is necessary for an accurate investigation of the differences in form between private and purchased freight charges, for if the two cost functions did not perform differently under various conditions, the type of analysis presented in this study would not be necessary.

The transportation functions of the common carrier and the charges for its services are almost totally regulated by the government. Freight moving across state boundaries is subject to the provisions of the Interstate Commerce Act and is regulated by the Interstate Commerce Commission; whereas, other intercity movement of freight is regulated by the various state public-utility commissions. Carriers are required by law to publish all of their rates and charges and file schedules of these rates with the proper governmental agency. The significance of this requirement to the shipper is that for a particular service performed by a particular carrier there is only one legal rate. The rate shown in the tariff is the rate that must be paid, and negotiations or contracts cannot be made giving discounts or rate reductions for larger volumes of freight, shipments with higher carrier profit, and so forth.

The total cost of transportation for a company should not be construed to mean the amount of money paid directly to a carrier or for operation of a private fleet, for shipments which arrive with freight charges prepaid usually have the cost of the transportation hidden in the price of the article. The real cost due to transportation is (1) the difference in the price of goods leaving the supplier's warehouse and the cost of those goods if delivered at the expense of the supplier, (2) the difference in the price the outgoing goods bring at the company's warehouse and the price received when delivered by the company, and (3) the direct charges for transportation paid by the company. For example, an owner of a company which receives all of his freight F.O.B. destination and designates all of his outbound shipments F.O.B. origin may incorrectly assume that his company has no transportation cost. However, if the company assumed the payment of the incoming freight charges, the owner would probably find that the net price of the goods would be reduced by the shipper. In a like manner the prepaid delivery of goods to his customers would permit a reasonable allowance for transportation to be added to the net price of the articles.

These assumptions of absorbed freight charges are not necessarily valid in all cases, however. Under uniform-delivered pricing methods, namely, postage-stamp pricing and zone pricing, a uniform average transportation charge is added to the cost of the product no matter what the actual cost of transportation may be, and probably no savings would result from the consignee picking up the shipment at the supplier's plant. Factors such as these should be considered when determining the cost of the transportation function and when anticipating

savings resulting from private fleets. Negotiations for price reductions on incoming shipments and for transportation charge allowance on the cost of outbound goods should be arranged with customers and suppliers when pickup and delivery of goods can be performed by private fleets.

Most of the rates published by common carriers fall into three categories: class rates, exception rates, and commodity rates. Instead of assigning a price for the transfer of each of the multitudinous commodities shipped by freight, carriers have found it convenient to group all articles into several "classes" and quote rates on the classes of freight. The class into which a commodity will be placed is determined by factors which basically describe the cost to the carrier of transporting the article and the value to the shipper of having the freight moved. Each class of goods is assigned a numerical rating which is used in the application of the freight tariff to find the actual charge for transporting the article between specified points.

An exception rating is one which deviates from class rating in specific cases. The exception rating is usually lower than the class rating and is applicable in certain areas, by designated carriers, or on specified commodities. The application of the exception rate is based on economic factors of the commodity and of the geographical area. The utilization of commodity rates is generally limited to important commodities which move regularly in large quantities or to bulky, low-grade commodities such as sand or gravel which cannot stand even the cost of the lowest class rate. In nearly all cases the commodity

rate is lower than the similar class rate.

The publication of three different rates for a commodity may seem to contradict the previous statement that there is only one legal price for a transportation service. However, the application of rules or precedence for freight rates eliminates all but the proper rate. A commodity rating supersedes both the class rating and the exception rating while an exception rating, when applicable, supersedes a class rating.

There are two levels of common-carrier rates which are applicable at two levels of shipment weight--carload or truckload and less-than-carload or less-than-truckload.* In addition to these levels of rates there is the additional stipulation that for less-than-carload shipments the freight charge must be greater than a certain minimum charge. This minimum charge is usually equal to the cost of transporting 100 pounds of class-100 freight[#] between the designated points.

The carload rate is reserved for freight which is shipped from one station, in or on one car, in one calendar day, by one shipper for delivery to one consignee at one destination, and weighing at least the specified minimum weight for the commodity in question. Shipments which do not meet these conditions are charged for at the higher less-than-carload rate.

In addition to the basic freight charge for the movement of

*When the terms "carload" or "less-than-carload" are used, they are used to also include truckload and less-than-truckload respectively unless otherwise stated.

[#]The term "class-100 freight" denotes "first-class freight". The classification of a commodity is given as a percentage of the first-class classification, which is the base figure from which all freight charges are calculated. The charge for class-80 freight will therefore be 80 per cent of the charge for class-100 freight.

freight, the shipper or consignee may be faced with supplementary charges before the final transportation service is completed. Demurrage charges (a penalty charge for overtime use of railroad cars in loading and unloading carload shipments), switching charges, local drayage charges, and extra handling expenses may be incurred; these expenditures should be included in the analysis of purchased transportation costs.

The factors which influence the freight classification into which commodities are placed, or in other words put a price tag on the transportation service, are important to an understanding of the relative costs of performing equal transportation services with private fleets. Knowledge of classification factors will also aid in evaluating the worth of the shipment of goods with company-owned trucks, as will be explained in a later chapter.

Some of the more important elements of assignment of commodities to freight classes will be presented below for foundation of later analyses; the factors listed are not meant to be described as necessarily the most important to common-carrier rates, but are given as being the most relevant to private fleet pricing of freight charges.

The density of a commodity represents one of the most important transportation characteristics to be considered in the classification of freight. Since freight is priced by the cost per 100 pounds, it logically follows that freight which is light and bulky must be given a higher classification and therefore must be charged for at a higher rate per hundred-weight. The method in which the article is packed also determines the relative amount of space which the shipment occupies in the carrier's vehicle. It is for this reason that wheeled

plows, for example, are classified 200 when shipped by motor carriers "set-up, loose" and are placed in the 85 class when transported "knocked-down, in packages".

The classification rating of a commodity will vary directly with the intrinsic value of the article. This factor affects the classification in two ways. The cost of transporting a valuable article is high because of its replacement cost in case of theft, pilferage or damage and because of the resulting high cost of insurance. The shipper of a high-value commodity is able to pay more for its transfer than for the shipment of a lower priced article, and therefore the "what-the-traffic-will-bear" factor contributes to an increase in classification.

The susceptibility of the commodity to theft contributes to its transportation pricing. Small desirable objects such as hylon hose, radios, or tobacco must therefore have a higher factor of classification than larger items or items with less personal desirability like home furnaces or laundry presses. The mobility of the smaller articles makes them easier prey for pilferers.

The fragility of the commodity and its ability to damage other articles in transit represents a cost of transporting freight. The freight which is easily damaged requires careful, expensive handling; it cannot be stacked high in the carrier's vehicle; and additional cost is incurred in replacing broken items. Liquids such as paint can cause damage to other items shipped in the same vehicle and must be classified higher because of this characteristic.

The relative weight given the above factors in determining a final classification of a commodity is not definitely stated in theory

or practice. Neither are there any mathematical relationships between classification and density or value. The classifications most commonly used by carriers are arrived at by committees of men in the transportation field and are determined by their individual notions of which factors and characteristics are most important in the case of each commodity.

Most of the rail carriers in the United States use the classification of commodities given in the Uniform Freight Classification, and similarly the greater part of the motor carriers participate in the use of the National Motor Freight Classification. Although these classifications contain important information concerning participating carriers, rules, and applicability, the section of major concern to a cost analysis is the listing of articles. A myriad of articles, including descriptions of their form and packing, is listed in this section. Beside each item three numbers are given: less-than-carload rating, carload minimum weight, and the carload rating. In general it can be said that the ratings given in the Uniform Freight Classification are equal or very close to those listed in the National Motor Freight Classification for the same article except in special cases in which there are intended differences for competitive reasons. However, the minimum weights for TL* shipments are significantly lower than the minimum weights listed for CL shipments in many cases.

To determine the final cost of shipping a specified group of articles between two designated points, information concerning the

*The abbreviations CL, TL, LCL, and LTL used in this thesis represent the terms carload, truckload, less-than-carload, and less-than-truckload respectively.

commodity is taken from the classification, and data associated with the geography of the shipment is taken from the applicable tariffs. Most common carriers participate in the use of tariffs which are published by tariff bureaus, and therefore class rates in the area of the country in which a specific tariff is used are equal. Tariffs list rate base numbers (which are actually miles) for each pair of cities in the geographical area served by the tariff. Also included is a "conversion table" to find the cost or rate per hundredweight for 100-class freight for any given mileage or rate base number. Extractions from rail and motor tariffs for the Southern region are given in Table I.

In summary, the procedure to follow to obtain the transportation cost for class-rate commodities is as follows. First, find the freight class of the article from the classification publication and the rate base number between the origin and destination of the shipment from the tariff; also find the class-100 rate in the tariff which corresponds to the rate base number for the trip. If the shipment weight is larger than the minimum carload weight denoted in the classification for the article in question, or is billed at that weight, the carload rating is used; otherwise the less-than-carload rating is selected. The cost of the shipment is the classification multiplied by the class-100 rate multiplied by the weight of the shipment expressed in hundredweight.

However, because of the difference in magnitude between the carload classification rating and the less-than-carload classification rating, the shipper may save on shipping charges if the carload rating is applied to the carload minimum weight even though the shipment is

actually less than the minimum weight. Consider, for example, a shipment of 27,500 pounds of 85LCL/50CL-class freight to be shipped a distance of 575 miles; the minimum carload weight for the articles is 35,000 pounds. From Table I, it is seen that the class-100 rating for the distance of the shipment is \$3.05.

Allow the following notation to be introduced:

R_C = Rate (per cwt.) of a carload shipment,

R_L = Rate (per cwt.) of a less-than-carload shipment,

L_R = Rate (per cwt.) of local drayage charges,

W = Weight of any shipment,

W_B = Shipment weight at which LCL charges equal CL charges,

C_T = Total cost of the shipment, and

M = Carload minimum weight.

The less-than-carload and carload rates for the shipment in question then become

$$R_C = \$3.05 \times .50 = \$1.53$$

$$R_L = \$3.05 \times .85 = \$2.59.$$

If it assumed that there will be no local drayage charges, that is, both shipper and consignee have railroad sidings adjacent to their warehouses or the shipment is transferred by motor carrier (which offers door-to-door truckload service), the total cost of the shipment will be,

by LCL and CL calculations respectively,

$$C_T = W \times R_L = 27,500 \times \$2.59 = \$712.25$$

$$C_T = M \times R_C = 35,000 \times \$1.53 = \$535.50.$$

It can be clearly seen that the lower--and legal--charge results from calculating the cost at the high weight and the lower rate.

To solve for W_B , the "break-even" weight at which the charges solved by LCL rates equals those calculated by CL rates, the C_T for the two methods are set equal to each other, and the equation is solved for W_B .

$$W_B \times R_L = M \times R_C$$

$$W_B = \frac{M \times R_C}{R_L}$$

In the example,

$$W_B = \frac{35,000 \times \$1.53}{\$2.59} = 20,675.7 \text{ pounds,}$$

and the total cost of the shipment at the break-even point shown by the two methods is

$$C_T = W_B \times R_L = 20,675.7 \times \$2.59 = \$535.50$$

$$C_T = M \times R_C = 35,000 \times \$1.53 = \$535.50$$

In Fig. 1 the relationships described above are shown in graphic form. The line OA is the LCL cost line whose equation is $C_T = R_L \times W$,

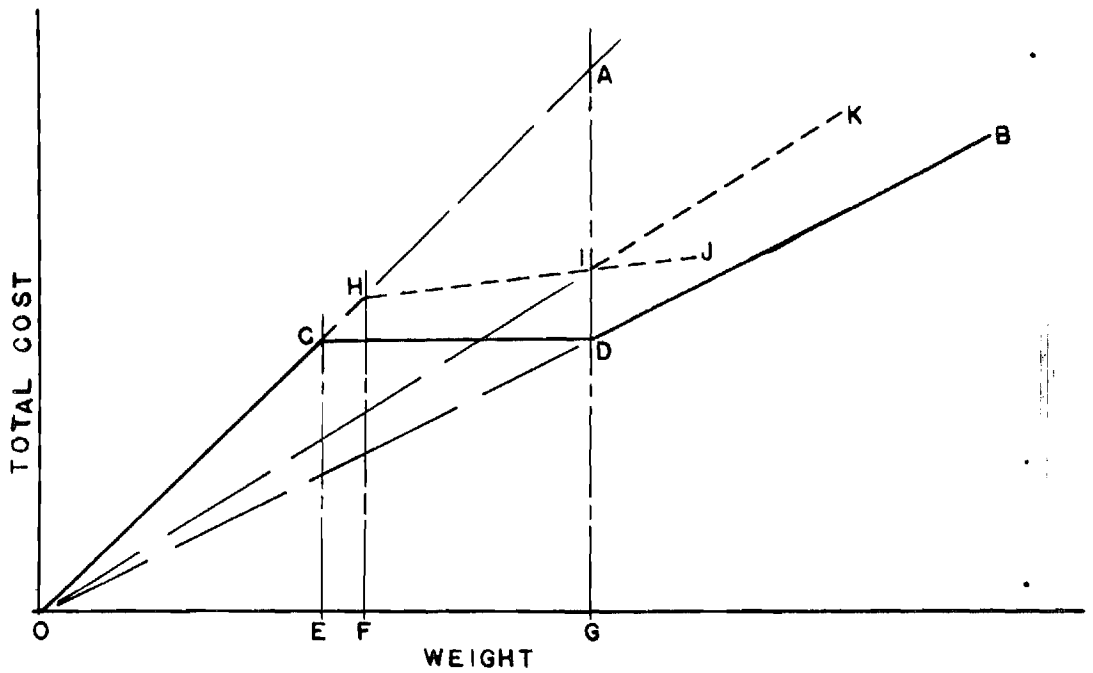


FIGURE 1
GENERAL WEIGHT - COST CURVE FOR MOTOR/RAIL SHIPMENTS

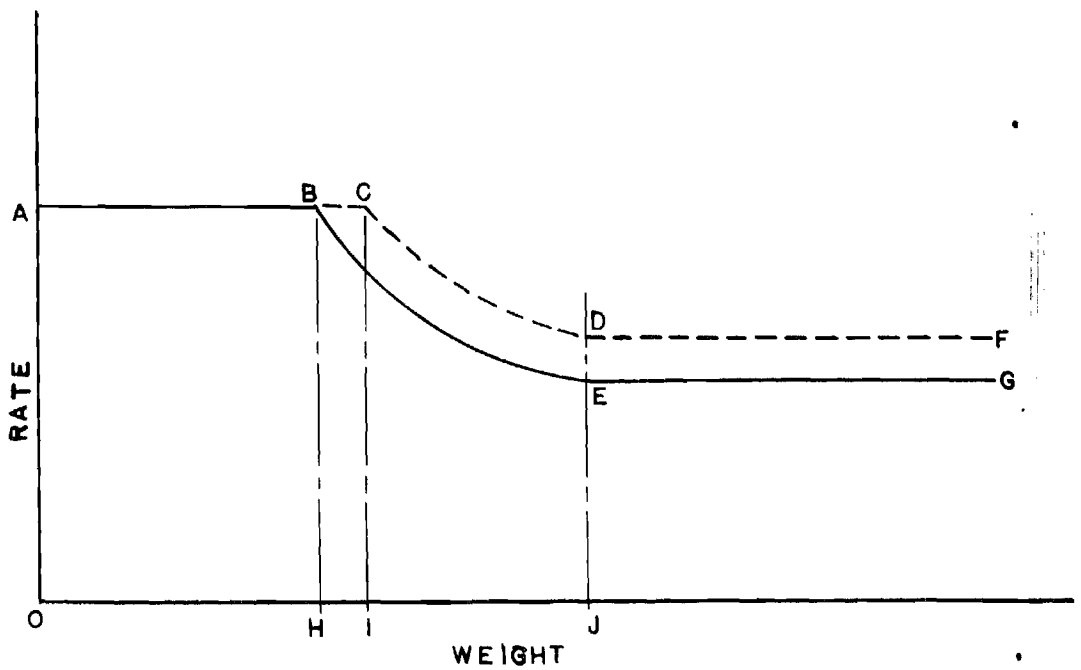


FIGURE 2
GENERAL WEIGHT - RATE CURVE FOR MOTOR/RAIL SHIPMENTS

and the line represented by ODB is the CL cost line which has the form $C_T = R_C \times W$ and is valid for shipment weights in excess of the carload minimum weight. The horizontal line, CD, is the line which represents the constant freight charge between W_B , denoted by E, and the carload minimum weight, shown by G in the figure.

Let the assumption now be made that an additional cost of \$0.25 per hundredweight is incurred by the shipper and/or consignee in transferring a carload shipment between the plants and public railroad sidings. This payment could be made to a local contract carrier, or it could be the cost of moving the freight with equipment owned by the shipper or consignee. Since most railroads--and all motor carriers--provide pick-up and delivery service on less-than-carload shipments this supplementary charge would not be applicable on LCL shipments.

The cost equation for the LCL-size shipment still remains

$$C_T = W \times R_L,$$

but the equation for the shipment when billed at the carload rate becomes

$$C_T = M \times R_C + W \times L_R \quad (\text{for } W_B \leq W \leq M) \text{ and}$$

$$C_T = W \times R_C + W \times L_R = W(R_C + L_R). \quad (\text{for } W > M)$$

Solving for W_B , as before, gives

$$W_B \times R_L = M \times R_C + W_B \times L_R$$

$$W_B (R_L - L_R) = M \times R_C$$

$$W_B = \frac{M \times R_C}{R_L - L_R}.$$

Now substituting from the example

$$W_B = \frac{35,000 \times \$1.53}{\$2.59 - \$0.25} = 22,884.6 \text{ pounds}$$

one can see that the "break-even" weight, W_B , has increased from 20,675.7 pounds to 22,884.6 pounds, and the cost of the 27,500 pound shipment has increased to

$$C_T = M \times R_C + W \times L_R$$

$$C_T = 35,000 \times \$1.53 + 27,500 \times \$0.25$$

$$C_T = \$604.25.$$

Figure 1 shows that the cost of a shipment of weight W_B increased from point C to H, and the actual value of W_B moved from E to F when additional terminal charges were assessed. The cost of the shipment between the weights of W_B and M is not constant in this case, but the cost line has a slope of \$0.0025/pound as represented in the general case by the line HI. The slope of the cost line for that portion of the curve above G in the figure has also increased. This cost line, represented by OIK has the equation $C_T = W(R_C + L_R)$ with slope $(R_C + L_R)$ instead of the previous slope of R_C .

Figure 2 shows the behavior of the effective rate when the shipment weight is increased. The line AB is a distance of R_L from the zero axis, and EG is a line with a constant R_C distance from the horizontal axis. The points H, I, and J correspond to the weight of W_B without local hauling charges, W_B with drayage charges, and the carload minimum weight respectively. The dotted line in the figure shows the effective

rate when additional charges are incurred due to local drayage charges. The cost of the drayage charge per hundredweight is denoted by the vertical distance between line EG and line DF. The effective rate curve between the weights W_B and M are obtained by dividing the C_T by the corresponding W. These relationships shown in Fig. 1 and Fig. 2 will be utilized in a later chapter to compare purchased transportation cost with the cost of providing equivalent service with private fleets.

CHAPTER III

COST CHARACTERISTICS OF PRIVATE FLEETS

The major difference between the costs of purchased transportation services and the expense of privately operated fleets is the fixed-cost characteristic of the operation of the private vehicles. Although it is obvious that a shipper incurs liability only when he uses the services of a common carrier, the exact cost of not operating a group of trucks, or not operating them at full capacity, may not be as obvious. This chapter will attempt to show the cost characteristics of the private carrier so that these factors of expense may be examined in relation with purchased transportation costs in the next chapter.

The two most commonly used units of measuring the costs of operating highway vehicles for movement of freight are cost per ton-mile of freight moved and the cost per mile of truck travel. Both methods have their advantages under the proper conditions, but since the ton-mile unit is not applicable in the general case of common-carrier rates, the truck-mile or distance-of-shipment unit of measurement will be used in this analysis.

Trucks which are operated for transfer of company freight in lieu of the exclusive use of common carriers may be acquired by two basic methods--complete ownership of all vehicles in operation or long-term leasing of all trucks in the fleet--or a combination of the two methods. Under both methods of operation the same problem arises as to the manner in which the trucks should be operated, and the same type of costs is incurred even though the magnitude and

origin of the costs with each method will vary under various operating conditions.

The first approach towards an understanding of fleet operating cost relationships is to find how that cost varies with the "volume of output" or the distance over which the fleet is operated during a given time period. A common method of finding cost functions is to delineate the cost accounts into two categories, those which vary with output and those which remain constant with output. Dean⁷ states:

There are several approaches to an estimate of cost functions:
 (1) Classification of accounts into fixed, variable, semi-variable, on the basis of judgment and inspection. (2) Estimation of the relationships of cost-output on the basis of engineering conjectures. (3) Determination of the cost function and the degree of output variation by statistical analysis.

The first approach mentioned above is an accounting method and, in most cases, turns out to be the simplest procedure. The statistical approach utilizes techniques such as multiple correlation analysis to determine functional relations between cost and other important variables, and the engineering approach consists of a systematic inquiry into the physical relationships which affect the variables concerned to determine how the cost function is expected to behave under increases in output. In estimating the cost of operating a highway vehicle over a fixed distance under varying loading conditions, the engineering approach may be used to determine the magnitude of the increase in the total operating costs for the trip that result when

⁷Joel Dean, "Managerial Economics," Handbook of Industrial Engineering and Management, W. Grant Ireson and Eugene L. Grant, editors, (Englewood Cliffs: Prentice-Hall, Inc., 1955), p. 77.

the cargo loading is increased. It should be remembered that the results obtained from any of the three approaches are estimates of the actual cost-output function, and the limitations that estimates present should be kept in sight.

The accuracy of the cost functions of fleet operations depend mainly on the accuracy of the cost-keeping records. The intent of the records is to arrive at the type of graphic representation given in Fig. 3, and to do this requires the correct classification of costs into the three types. Although the classification into which a cost is placed will probably vary with different companies and with the number of accounts that are used, the cost of operating a company-owned fleet will usually contain the following expenses.

Fixed Costs:

1. Property taxes on equipment and vehicles.
2. Insurance on vehicles.
3. Vehicle license fees.
4. Interest on investment in equipment and vehicles.
5. Storage expense for vehicles.
6. Fixed expense of maintenance and repair shop.
7. Fleet supervision expense and other overhead not assigned.

Semi-fixed Costs:

1. Depreciation.
2. Drivers' salaries.
3. Batteries.
4. Cargo insurance.
5. Cleaning, maintenance, and repair expense.

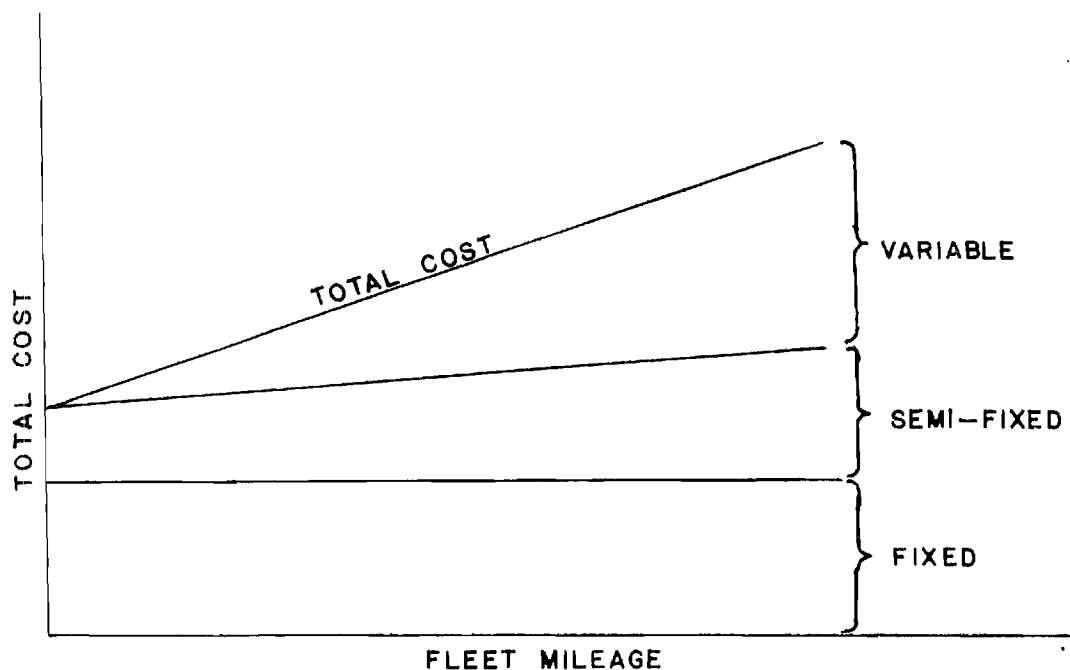


FIGURE 3
GENERAL TOTAL COST - FLEET MILEAGE CURVE FOR PRIVATE FLEETS

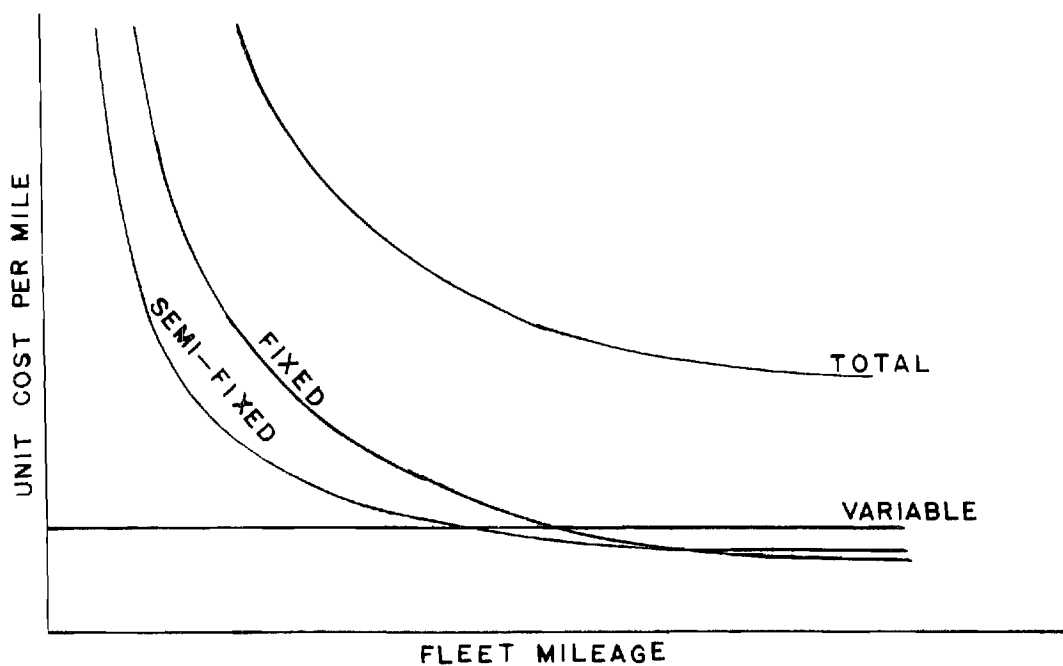


FIGURE 4
GENERAL UNIT COST - FLEET MILEAGE CURVE FOR PRIVATE FLEETS

Variable Costs:

1. Gasoline or other motor fuel.
2. Oil and grease.
3. Tires.
4. Taxes on gasoline, oil, and tires.

The expense of drivers' salaries is listed under semi-fixed costs, but this expenditure may be classified as fixed, semi-fixed, or variable according to the method of payment. If the driver is paid a constant salary during every week, the expense will of course be fixed; payment of drivers by the trip results in a pure variable cost. In some cases union contracts specify two methods of payment, a straight salary basis and a trip basis, and the actual payment is made under the calculations which result in the highest salary. An expense of this type would be semi-fixed.

The actual cost of depreciation is not necessarily the same as the accounting "allowance for depreciation". A company may charge a constant amount each year to depreciation, or in other words use the straight-line depreciation method, and thereby assume the expense to be a fixed one. However, by engineering conjecture, one could surmise that functional depreciation, caused by changes in style and models, would continue even though the vehicles were entirely idle and that physical depreciation, caused by wear and deterioration, would cause the depreciation cost to increase as the equipment is operated more. Therefore, it is probably advisable to classify the expense as semi-fixed.

When the entire fleet of trucks is acquired on a long-term lease, the allocation of the costs into expense types depends on the contract which the lessee and lessor negotiate. In most cases the cost of operating a leased fleet of trucks also falls into the fixed, semi-fixed, and variable classifications. A typical contract may include expenses which are classified in the following manner.

Fixed Costs:

1. Fixed rental fee for truck and trailers.
2. Storage expense.
3. Supervision expense.

Semi-fixed Costs:

1. Drivers' salaries.
2. Cargo insurance.

Variable Costs:

1. Variable leasing fee for truck and trailers.

However, some other expenses may be paid by the lessee if the contract so states. For example, the operator of the trucks may be required to pay for gasoline for the vehicles. Since most operators usually have more trailers than tractors so that some of the trailers remain at the loading docks while others are being used on trips, the rental fee for the trailer may be a flat monthly rate and the expense for this item would be entirely fixed.

The fixed costs of truck fleets can be reduced by purchasing or renting on long-term leases a core of trucks that will handle the volume of profitable freight shipped under normal conditions and supplementing this core by renting extra trucks on short-term leases.

In this case the rental payment for the extra trucks may be on a per-mile basis, and the fixed costs of these leased vehicles is eliminated completely. Even when the fixed rental fee is included in the short-term lease, the fixed cost of the additional rented trucks is incurred only during periods when the capacity of the trucks is being utilized to a high degree.

In moving vehicles from city to city the direct costs which were described above are not the only expenses which a private carrier must assume. To these expenditures must be added the cost of handling the freight, the cost of lost or damaged cargo not covered by insurance, and the cost of expanded dock and loading facilities. In allocating these expenditures for facilities which are used for loading both the company's trucks and common carrier's vehicles, the proportion of expense charged to the private fleet operation should not be larger than the proportion of use which the company's trucks receive. Dock handling costs should not be charged to the fleet if these costs are not also charged to the expense of shipping by common carrier unless the necessity for additional space was caused entirely by the private fleet. Again the method used for accounting is not important here, but the costs which are included in the comparative analysis of private and public transportation costs are important.

Figure 3 shows the general form of the variation of the three costs with truck mileage during a unit time period. When the fixed cost line, which shows as a constant value on the total cost curve, is divided by the fleet mileage to obtain the unit cost of operation, the fixed cost assumes the form of a reciprocal curve as shown in

Fig. 4. The variable cost line in Fig. 3 becomes a constant unit cost in Fig. 4. The semi-fixed cost function, which consists of a constant and a variable component, becomes another reciprocal curve which is displaced upward from the horizontal axis a distance equal to its variable component on the unit-cost curve. Figure 4 shows the sum of the fixed, semi-fixed, and variable costs of operating the fleet; this total unit cost curve gives the expense of operating a truck over a unit distance when the fleet is operating at a given volume or total fleet mileage. It is, of course, significant to note that as the use of the fleet in a given time period increases the unit cost of operating the trucks decreases.

In Fig. 5 the total unit cost curve of Fig. 4 is reproduced. In estimating the cost of hauling freight by private fleets some constant "cost per truck-mile" must be estimated even if the estimate is adjusted frequently. To make this estimate, a determination of the normal aggregate distance over which the trucks operate during a unit time period must be made. This mileage is represented by A in Fig. 5. The unit cost corresponding to this mileage is found by a vertical projection to the unit cost curve at B followed by a horizontal projection to point C, the normal unit cost to be used in calculating freight costs. The fallacy of using one constant unit cost of truck operation is obvious. If the amount of use of the fleet increases above the assumed normal usage, the unit cost will be less than the normal unit cost, and conversely, the unit cost will increase if the volume of usage decreases. If at the end of an accounting period it is found that the unit cost of operating the fleet is the value shown by E at

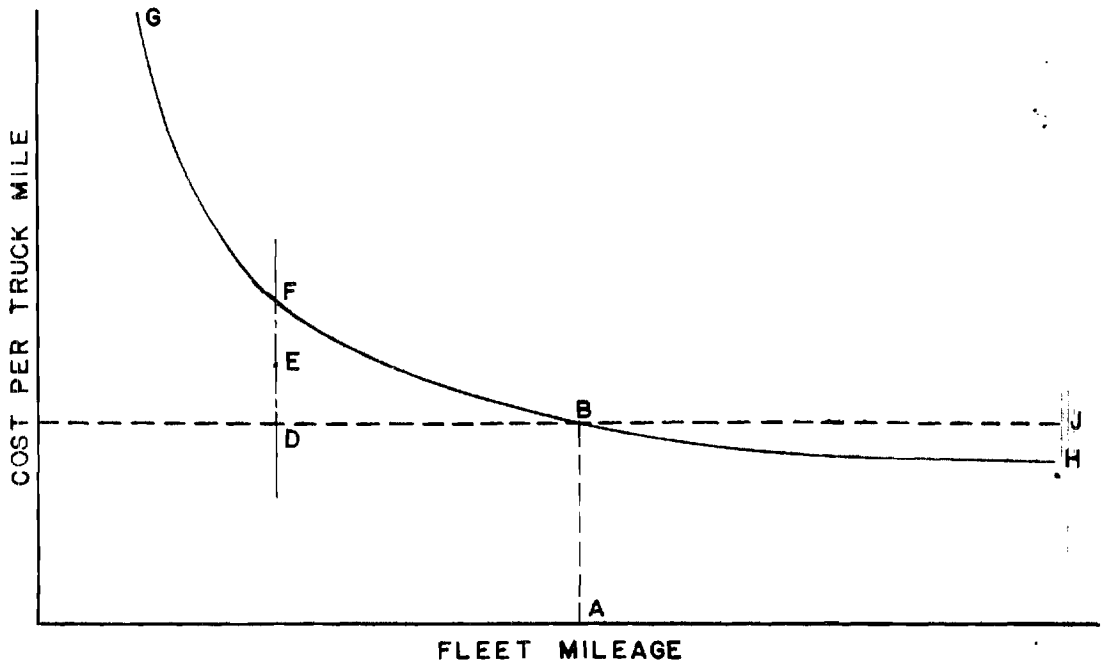


FIGURE 5
EFFECT OF REDUCED FLEET MILEAGE ON FLEET TRUCK RATE

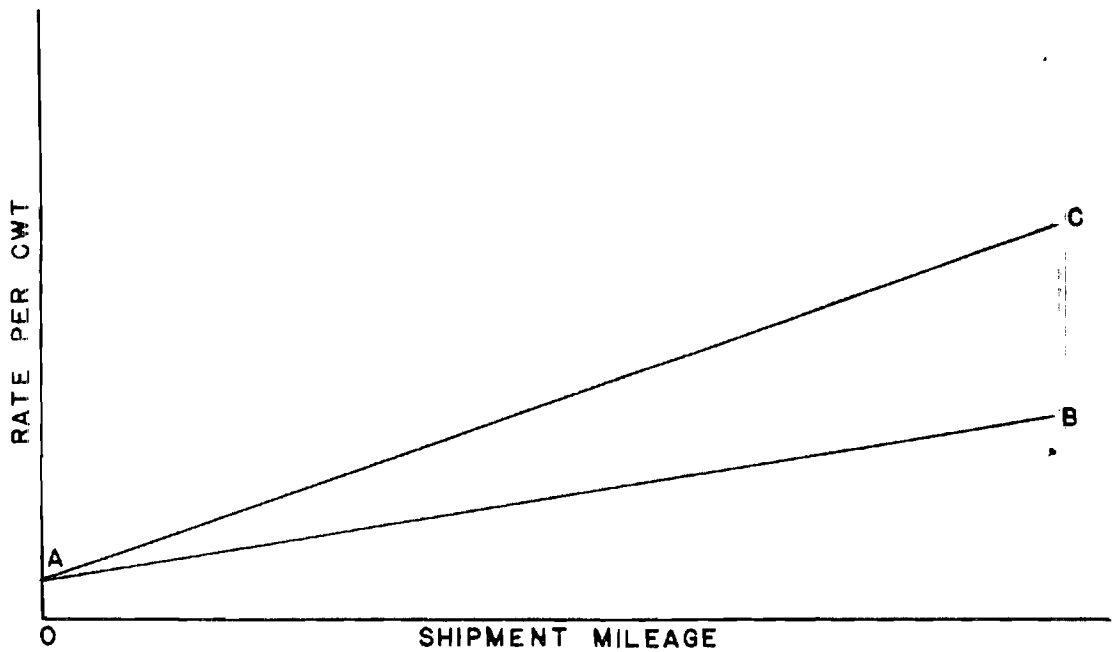


FIGURE 6
EFFECT OF TRUCK LOADING ON FLEET FREIGHT RATE

the corresponding fleet mileage, it may seem that the unit cost has increased to an amount larger than the normal cost and that there should be some explanation for the increased cost. However, if it is kept in mind that the constant unit cost shown by the line CJ is just valid for one level of fleet mileage, the error will not be made. Closer inspection of the cost curve will show that the cost shown by E is actually less than it was expected to be at that mileage. The distance DF is the variance in cost which resulted from a change in fleet miles, and the amount FE is the decrease in unit cost over that which it was estimated to be by the predetermined total unit cost curve.

Since the measurement of cost for common-carrier freight is given by the rate per hundredweight, it is necessary to calculate private fleet costs by the same method to make an effective comparison of the two costs. The freight rate per hundredweight for private-fleet shipments is calculated by dividing the cost of operating the truck over the mileage necessary to deliver the shipment (and in some cases to return back to the home terminal empty) by the weight of the shipment expressed in hundredweight. To this must be added the cost of handling the freight at the origin and destination of the shipment. Figure 6 shows that the freight rate will increase on a straight-line relationship as the shipment mileage increases. The distance OA in the figure represents the handling cost per hundredweight. The line AB indicates a shipment of relatively high weight while line AC denotes a shipment with lower weight. Since the total cost of moving the truck will be about the same for the high-weight shipment as for the low-weight shipment, the rate per unit of weight will be lower

if the truck is loaded nearer capacity.

The line AC in Fig. 7 shows that the cost of operating a truck will increase as more weight is added to the cargo. The function will not necessarily give the straight line which is shown in the figure, but since the exact properties of the line are not known the straight line is assumed for simplicity. In the development of cost curves for private fleets in the following chapter, it will be assumed that the total shipment cost is constant with the shipment weight as shown by the line AB in Fig. 7.

By dividing the values of the line AB in Fig. 7 by the corresponding shipment weights, the rate curve given in Fig. 8 is developed. For each distance of shipment there will be a curve of the form shown in the figure. As the shipment distance increases the rate will increase.

The private fleet cost relationships will be used in the next chapter to compare the purchased transportation costs with private fleet costs.

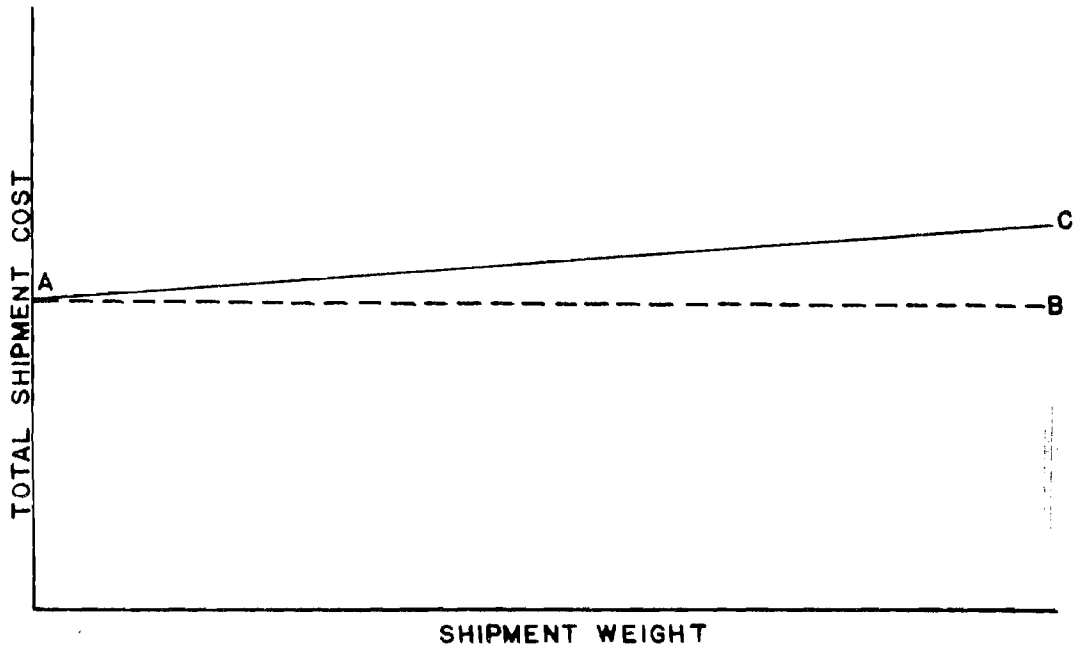


FIGURE 7
GENERAL SHIPMENT COST - WEIGHT CURVE FOR PRIVATE FLEETS

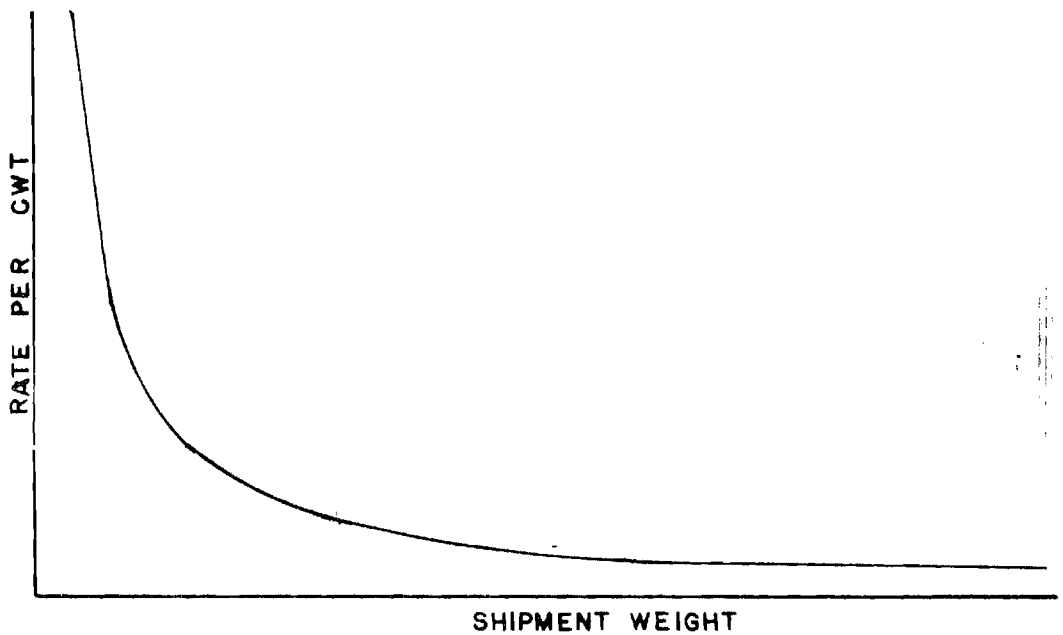


FIGURE 8
GENERAL RATE - WEIGHT CURVE FOR PRIVATE FLEETS

CHAPTER IV

ECONOMIC OPERATION OF PRIVATE FLEETS

One of the major duties of an industrial traffic manager is to select the type of carrier--rail, motor, air, or others-- to which various classes of shipments will be offered. Factors such as the cost of the transportation service, the total time the shipment is in transit, and reliability of the delivery date promised by the carrier influence the decision which the traffic manager makes. Each of the various types of carriers offers services which are the best suited to a certain type of freight, and it is the job of the traffic manager to select the carrier whose service characteristics match the requirements of each shipment of freight.

When a company offers all of its freight to various types of common carriers and does not own or rent trucks to transfer part of its own freight, the decision of the selection of the carrier is a problem which can be solved by an examination of the requirements of each shipment individually. A complete transportation cost and service analysis need not be made for each shipment, and it is quite likely that the traffic manager may develop certain principles and rules for shipment routing which make the job a rather routine, clerical duty. The point is that, except for the possibility of pooling or consolidating shipments and for the obligation of leveling his transportation business over several carriers, the traffic manager need not have information on every shipment arriving at and leaving his

plant to route any one particular shipment. When the company procures trucks and becomes a private carrier, this single-shipment procedure of freight routing no longer applies.

It has been shown in the previous chapter that there are certain fixed costs associated with private fleets which continue to accrue even when the trucks are idle for a period of time. Consider an example in which the traffic manager finds that by using the normal unit cost per mile for operating his fleet it is cheaper to route all of his shipments for the day by rail and not utilize his own trucks at all. It is easy to forget to add to the rail charges the cost of not operating his fleet. His procedure of testing each shipment cost individually has resulted in an erroneous total cost of transportation for that day's operations. It is necessary to examine daily both the incoming and outgoing shipments and the capacity of the trucks available simultaneously when routing freight by the company's fleet of trucks; the reasons for the concurrent treatment of all shipments will become evident later in the chapter.

To compare the relative monetary advantage of fleet-routed shipments over those routed by common carrier, or vice versa, it is necessary to be able to state not only that one has the advantage over the other, but to specify the magnitude of the difference. This difference in cost is useful in determining the measure of effectiveness of the private fleet or finding the worth of the fleet to the company, but it is still more important in the determination of the shipments which result in the greatest savings in transportation costs. Knowing the shipments which give the greatest advantage when routed by the fleet

will permit the trucks to be operated in a more profitable manner.

In the field of manufacturing economics the break-even analysis is utilized to determine the volume of output or sales at which the profit of the operating unit is expected to equal zero. With the break-even chart one can also find the expected profit or loss at any other level of output or level of sales. However, the break-even chart is valid for a short-run situation, and one would have to assume that the ratio of fixed and variable costs remained constant over this period of time and change in volume. This chart is produced by plotting the sales of the company's products and the associated expenses against the range of sales output or physical output on the abscissa of the graph. The vertical distance between these two curves is a measure of the profit (if the sales line exceeds the expense line) or the loss at any point of output. Under normal operating conditions the chart will show a break-even point; the area of profit will be on the higher output side of the point and the area of loss on the lower side. By the use of this break-even chart the management of the manufacturing concern can estimate not only the volumes of output at which profit is expected but also the expected magnitude of the profit or loss.

Perhaps this type of analysis may be borrowed for use in the field of transportation, for it will be useful to know at what level of truck capacity, for example, the cost of routing by the company's trucks is equal to the cost of equivalent purchased transportation and what the difference in cost will be at other levels of capacity. Let the difference in costs of private and public transportation be designated the "private fleet gain" which results from the proper

selection of shipments to be routed by the private fleet. Since it is expected that the fleet cost will generally be less than the common-carrier costs (otherwise there would be no advantage in the fleet) this case will be called "positive gain". A condition showing "public transportation gain" will be one in which the private fleet costs exceed the purchased transportation costs. Private fleet gain of the graphic transportation analysis will therefore be analogous to profit on the break-even chart, and public transportation gain will correspond to the loss on the manufacturing analysis.

As a first step in the development of the graphic transportation analysis, the relationship between the distance of a shipment of freight and the rates of private and purchased transportation charges will be shown. In the previous chapter the general form of the rate-mileage curve was discussed, and Fig. 6 showed the effect of cargo loading on the rate for private transportation for various shipment distances. The class-100 rates given in Table I will provide an equivalent type of curve for purchased transportation rates. Figure 9 shows the motor carriers' rates plotted against shipment miles for class-200, class-100, and class-50 rates. The fact that the class rates for rail and motor carriers are equal can be demonstrated by an examination of Table I. Since this study will consider only the coordination of private fleets with these two types of carriers, the plot of the motor rate in the figure is equal to the general common-carrier rates under consideration.

It will be noted that the class-200 rate curve is constructed by multiplying all values of the class-100 rate by two, and similarly

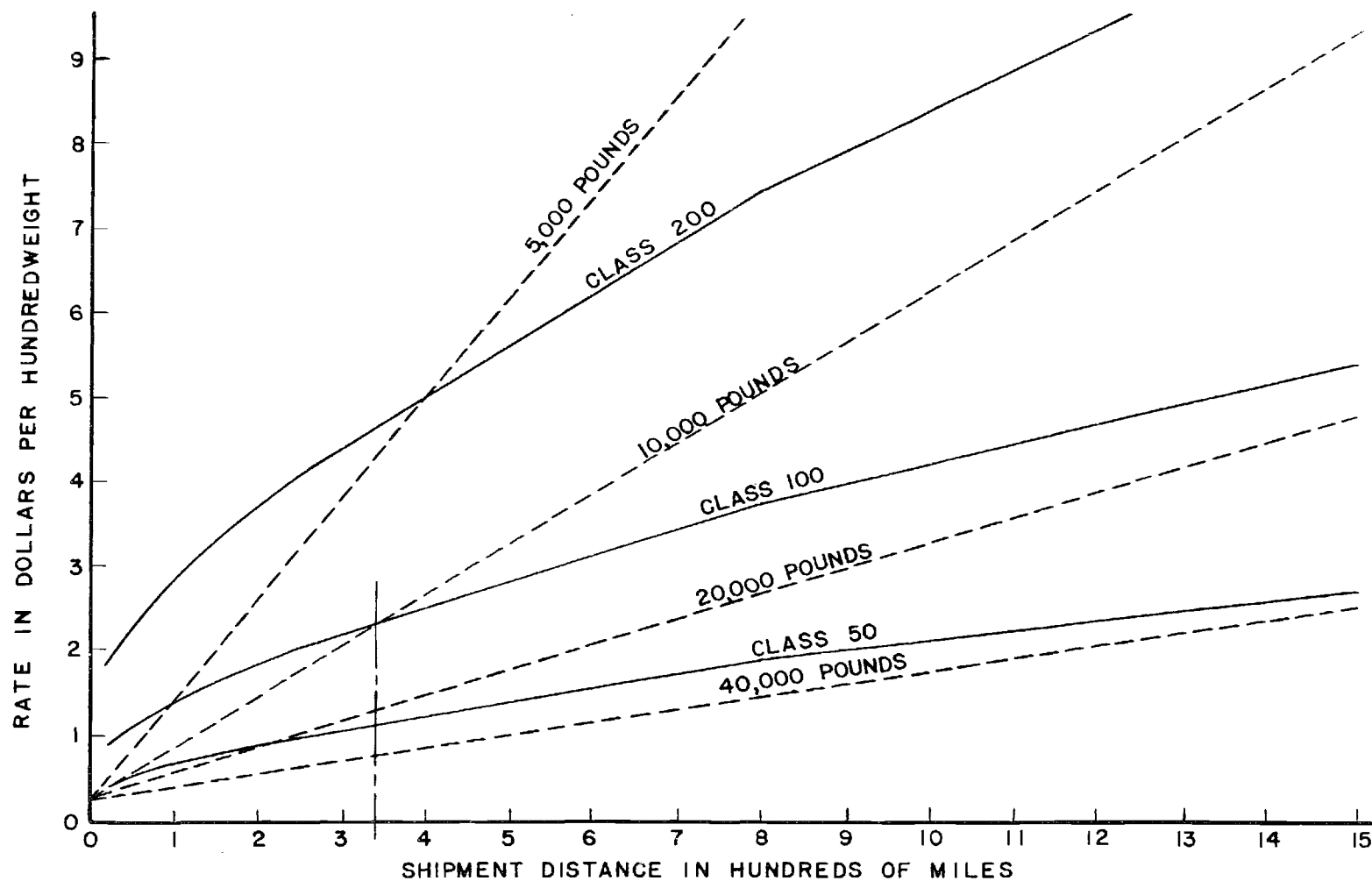


FIGURE 9
VARIATION OF PRIVATE AND PURCHASED TRANSPORTATION COSTS WITH MILEAGE

the class-50 rate is one half of the class-100 rate. For the private transportation a normal mileage charge of \$0.30 per truck-mile was assumed with an additional \$0.25 per hundredweight charge for cargo handling and shipment administration charges. These curves are also based on the operational procedure of requiring the trucks to return to the plant empty, therefore necessitating the actual distance of truck travel to be twice the distance of the actual shipment distance.

Figure 9 is useful in visualizing the general relationships between the two types of costs, but its utility is limited because of the requirement of additional data to make it applicable for specific conditions. If used in comparing the transportation costs for a class-100 commodity, the figure would show that on the average it would be necessary to have about a 20,000-pound load in the company's truck to make the routing show a private fleet gain. However, without knowing the carload minimum weight and the CL classification, it would not be possible to compare the class-100 curve with the 40,000-pound curve. The 40,000-pound shipment would most likely be a truckload shipment and could quite possibly be a carload shipment, and the private fleet costs could not be compared to the LCL rate for the purchased transportation. Figure 9 does show that, in general, the greater private fleet gain is realized with the shipments of shorter distance. The effect of the classification of commodities on the private fleet gain is also indicated in the figure. If the company finds that it cannot ship orders of its class-100 product except in 10,000-pound lots, the curve will show that the gain will be in favor of the private fleet for shipment distances less than about 330 miles, but the curve will

indicate public transportation gain for shipments over 330 miles. The conditions existing under the 10,000-pound order requirement and class-100 rate for the company's major product would discourage the decision to acquire a private fleet, except for distances of approximately 300 miles or less.

The rate-shipment mileage curves have been shown to be of limited use, but perhaps the construction of a rate-shipment weight curve will provide more quantitative aids to shipment routing. Figure 10 shows such a family of curves for a fictitious commodity having a LCL rating of 100, a CL rating of 60, and minimum carload weight of 35,000 pounds. The private fleet costs are derived from the following assumptions: A \$0.30 per truck-mile normal truck operating cost, no shipments loaded on return trips, and no handling cost. The curves are constructed for shipment distances of 250, 500, 1000, and 1500 miles in the manner described in the two previous chapters. It can be seen that the rate-shipment weight curves show the effect of the lower CL rates and also give the effective rate in the area of constant total cost for purchased transportation, that is, between 21,000 pounds and 35,000 pounds in the example shown in Fig. 10. All of the curves in the figure have only one break-even point, which is indicated where the private transportation rate curve crosses the purchased transportation rate curve for the corresponding shipment distance. The line AB is the locus of break-even points for the various shipment distances. Note that the weight at which the break-even point occurs increases as the distance of the shipment increases.

The rate of private fleet gain is determined in Fig. 10 by the vertical distance between the private and purchased rate curves. To

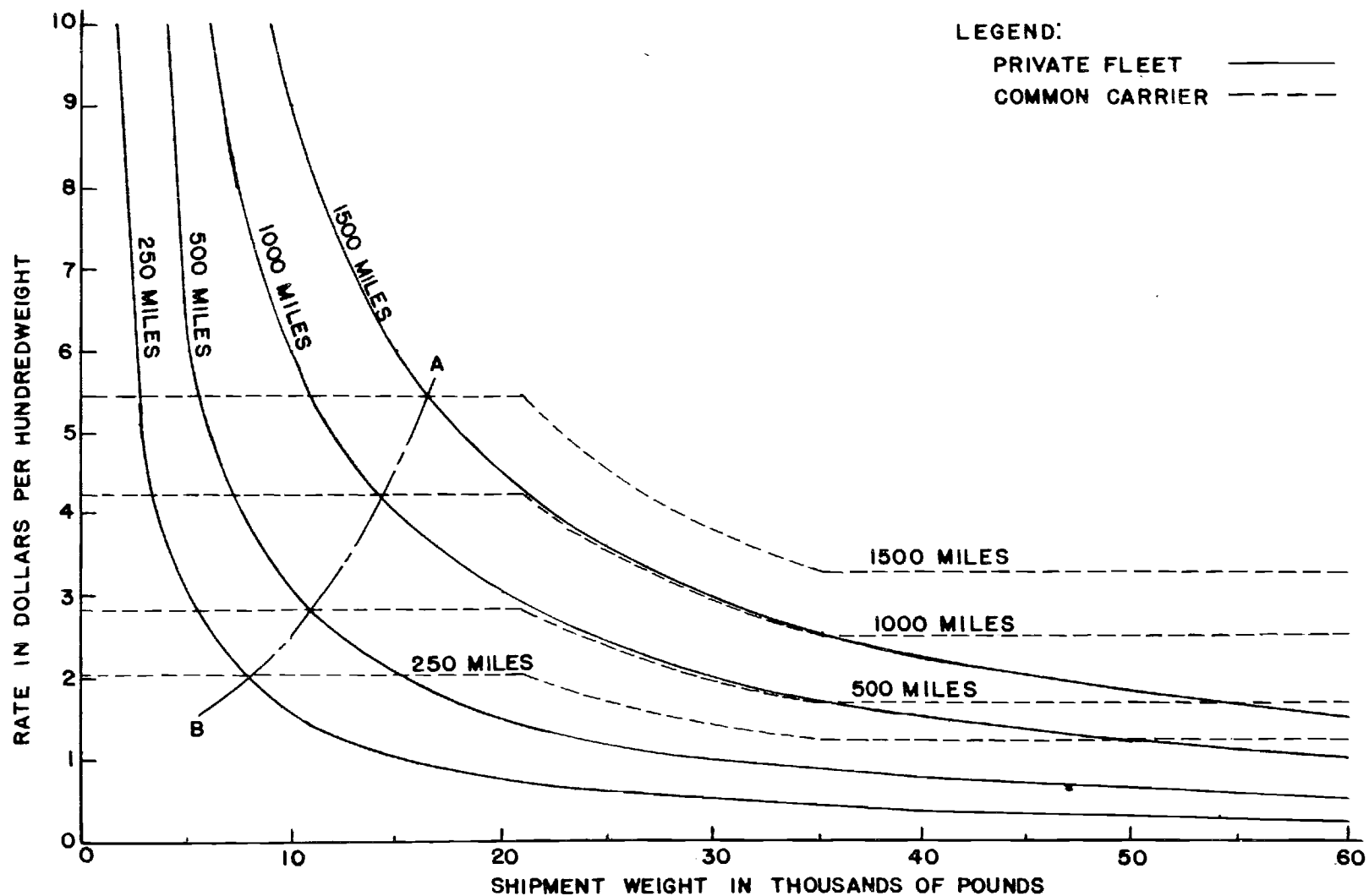


FIGURE 10
RATE CURVES FOR FICTITIOUS COMMODITY

make this representation clearer, these gains have been transposed to a gain curve in Fig. 11. It must be remembered that this group of curves is valid only for one freight class of commodities--those with a class-100 LCL rating, a class-60 CL rating, and a 35,000 pound minimum carload weight. A group of curves for another class of commodity would have different characteristics, and if the classification of the commodity in the National Motor Freight Classification differs from that in the Uniform Freight Classification in rating or minimum weight, the rate of private fleet gain for rail rate comparisons would differ from the gain calculated for motor rates.

There are several characteristics of the gain curves shown in Fig. 11 which deserve notice. First, it can be seen that as the shipment distance increases, the weight of shipment which is required before a positive gain is shown increases. At 250 miles all shipments with a weight of over about 7,300 pounds show private fleet gain, but at 1,500 miles a 16,600-pound shipment is needed to obtain a private fleet gain. Below the weight at which the carload rate is used (21,000 pounds in this case) the curve for the shipments of greater length is extremely steep. For the 1,500-mile curve the change in the gain between 10,000 pounds and 21,000 pounds is \$4.72. In routing a 1,500-mile shipment of about 20,000 pounds by the private fleet the company is in a precarious position. The gain is so sensitive to small changes of shipment weight in this area that a small error in the actual normal cost of truck operation might throw the gain below the break-even point and cause the company to lose money on the shipment if routed by private trucks.

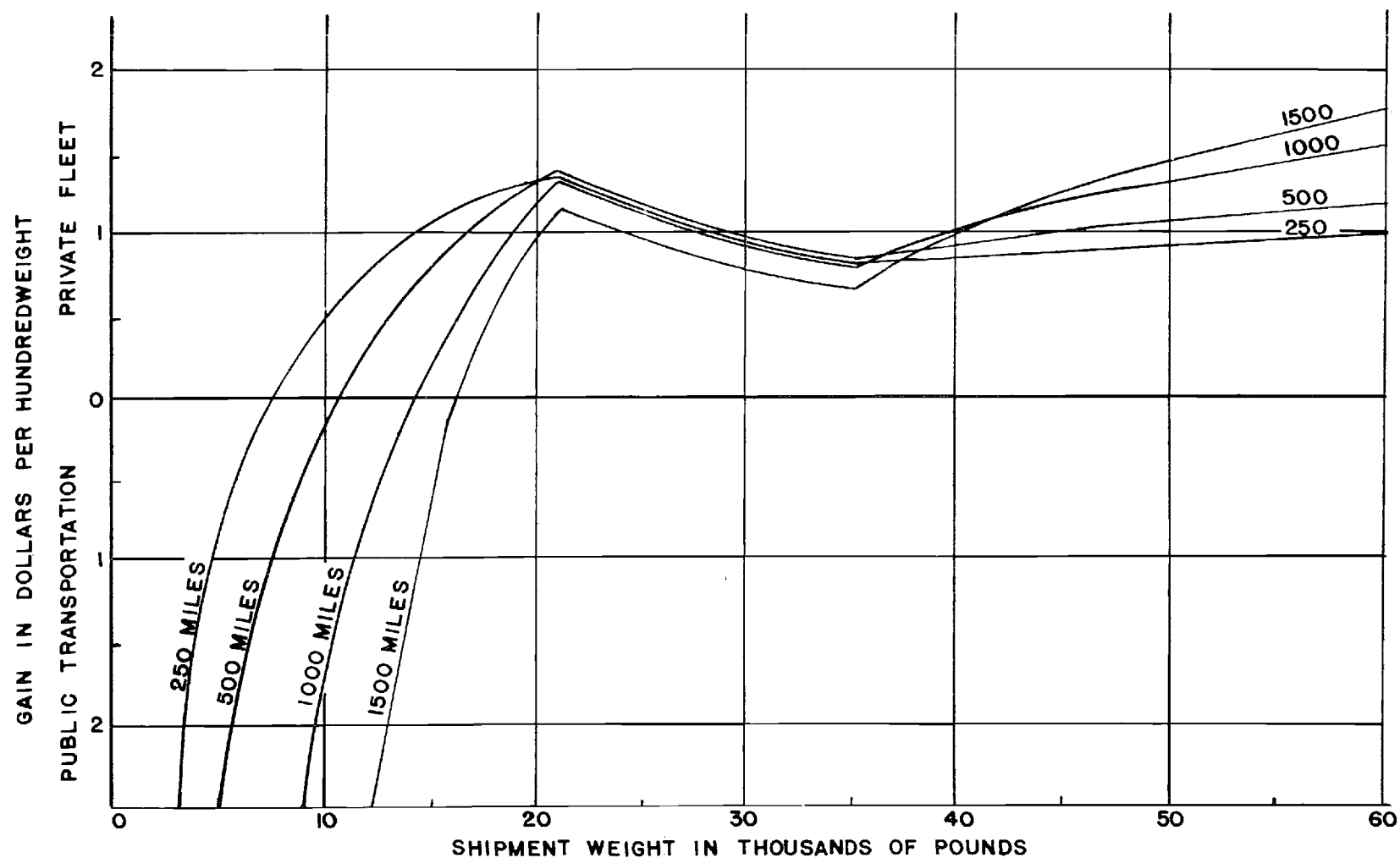


FIGURE 11
GAIN CURVES FOR FICTITIOUS COMMODITY

It is also interesting to note that the gain shown for the 1,500-mile trips is less than the gain for a 250-mile trip for all weights less than the minimum carload weight, and that at a weight a little past the minimum weight the longer trips result in a greater private fleet gain. The significance of this point is that a company having an opportunity to elect to use their own truck for either a 250-mile shipment or a 1,500-mile shipment could save more money by selecting the shorter trip and, at the same time, have the truck in use only about one-sixth of the time required for the longer trip. In the higher weights where the gain for the longer shipments exceeds the gain on the shorter shipments, management would have to decide if the additional gain shown by the longer trips is worth the additional amount of time the truck would be tied up.

Without a doubt the gain curve in Fig. 11 produced more useful information than the rate-shipment mileage curve in Fig. 9. However, the gain curve has one disadvantage. This curve gives the private fleet gain in units of dollars per hundredweight instead of in the universal common denominator--dollars of total cost. The dollar per hundredweight units cannot be added to obtain a total measure of effectiveness of the fleet. For example, knowing that one shipment by private fleet results in a gain of \$1.00 per hundredweight and another shipment produces a \$2.00-per-hundredweight gain, the gain for the two shipments cannot be determined unless the shipments weights are known. This defect can be overcome by the use of a plot of total shipment cost against shipment weight; this curve will have the effect of weighting the rate by the corresponding shipment weight.

Figure 12 shows the total shipment cost curves for the conditions described for Fig. 9. The total private fleet gains are taken from the

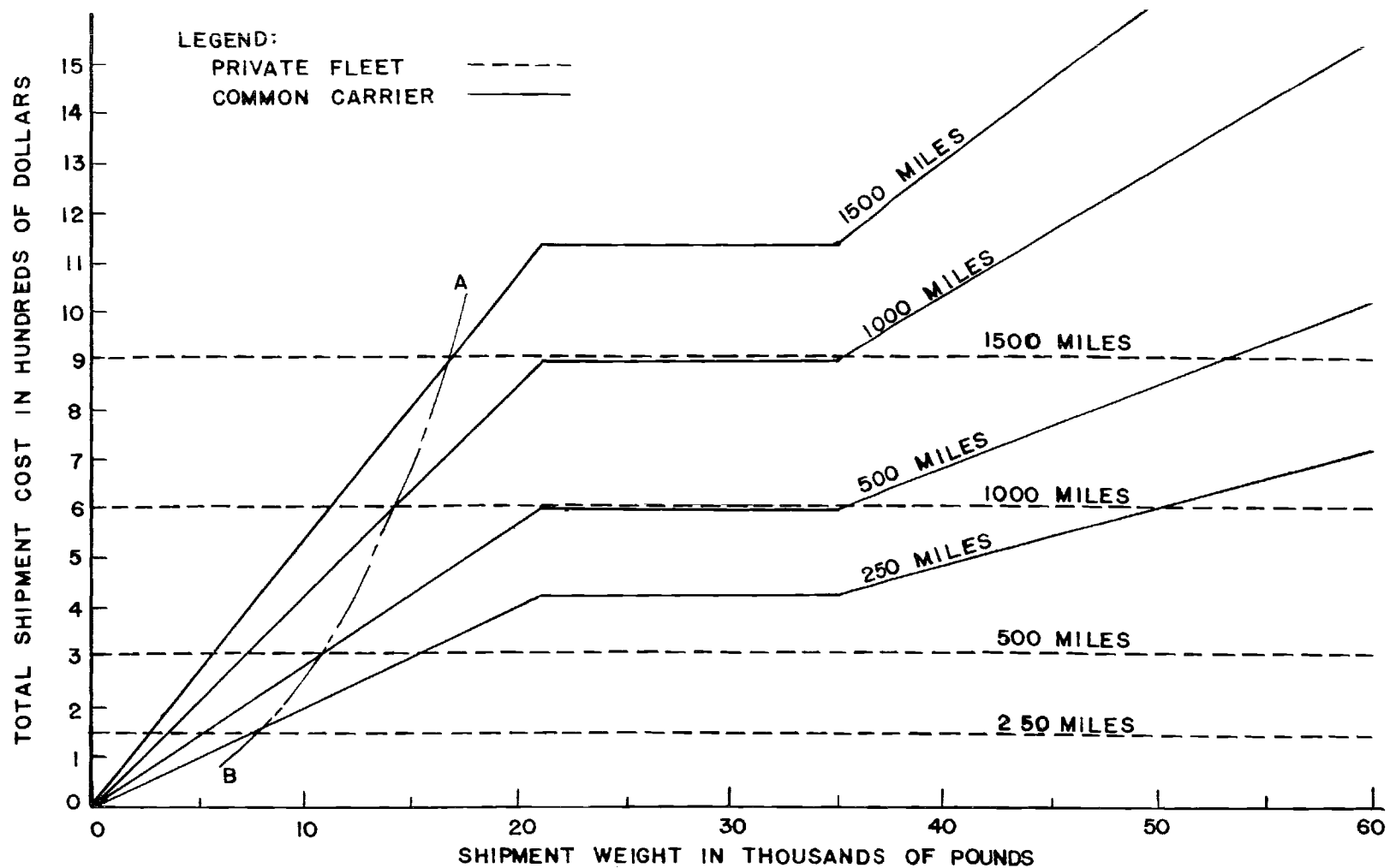


FIGURE 12
 TOTAL COST CURVES FOR FICTITIOUS COMMODITY

total shipment cost curves and are plotted in Fig. 13. The total shipment gain curve makes it easy to determine the gain which results when a shipment is routed by private fleet. This gain can be determined for any shipment weight and any shipment mileage if the correct mileage is interpolated.

It will be noted that the curves are all extended out to 60,000 pounds of shipment weight. However, there may be two limitations to using a truck loading of this magnitude. First, the density of the articles may be such that the truck cannot be loaded to that weight due to the volume limitation of the truck. This is quite possible since the truckload minimum weights listed in the classification have some relation to the amount of the commodity which can be loaded into a standard trailer. Secondly, the legal limitations on truck axle weight imposed by the various state road authorities may reduce the truck loading below the limitations imposed by trailer volume. Knowledge of the laws of the states into which the truck will travel and empirical knowledge of the loading characteristics of the commodity will enable a limiting weight to be placed upon the curves in actual practice.

The analytical approach to the total shipment gain curve will be given below to implement the graphical procedure described above. The total cost of common-carrier transportation can be described by the following three equations.

$$\text{For } 100 \text{ lbs.} < W \leq \frac{R_C}{R_L} (M),$$

$$C_T = R_L \times W;$$

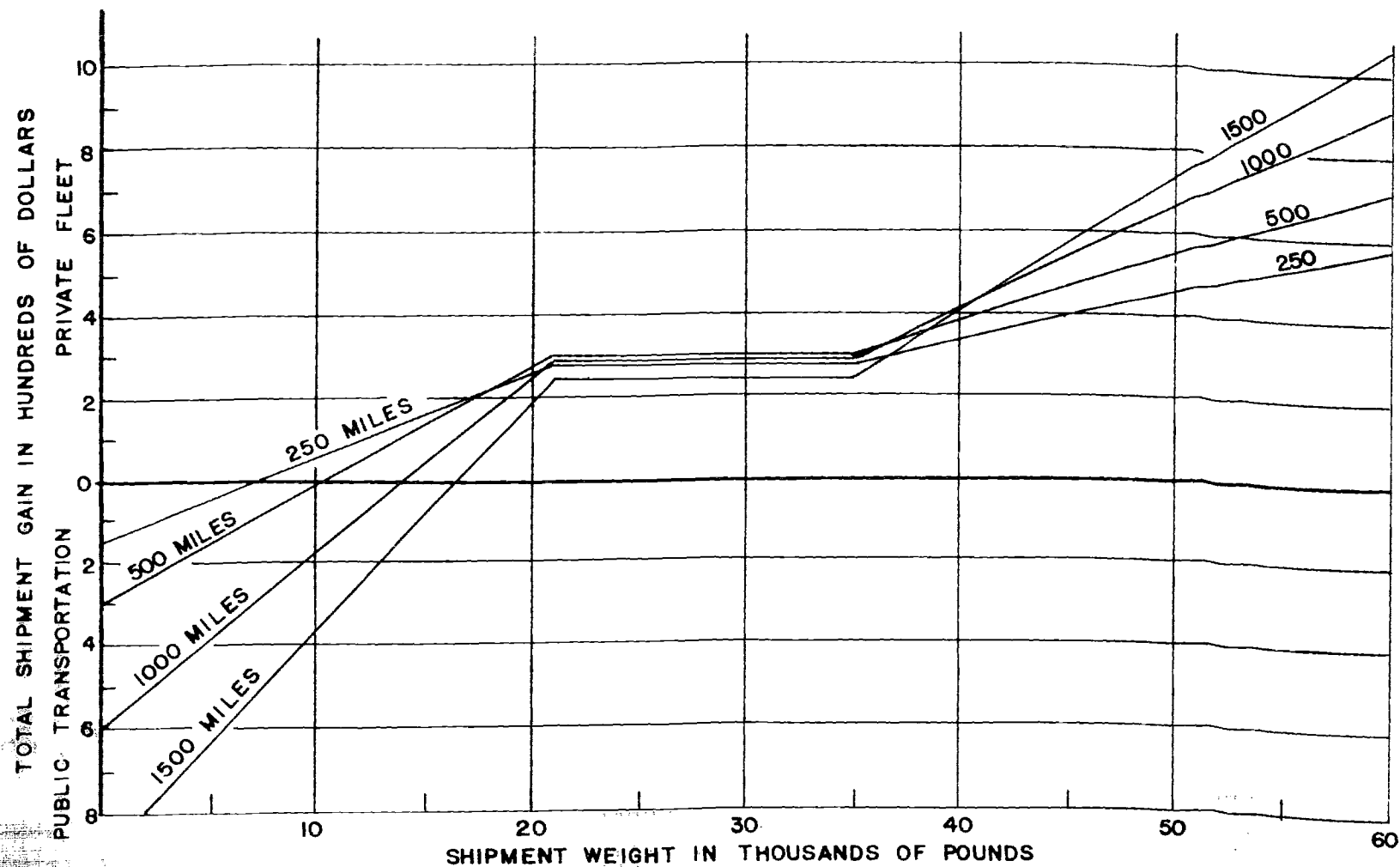


FIGURE 13
TOTAL SHIPMENT GAIN CURVES FOR FICTITIOUS COMMODITY

$$\text{for } \frac{R_C}{R_L}(M) \leq W \leq M$$

$$C_T = M \times R_C; \text{ and}$$

$$\text{for } M \leq W < \infty$$

$$C_T = W \times R_C.$$

These are the general equations for the purchased transportation costs shown in Fig. 12. The private fleet costs, which have been assumed to be equal for all shipment weights, is given by

$$C_T = R_M \times D \times 2, \text{ where}$$

$$R_M = \text{normal truck mileage rate and}$$

$$D = \text{distance of shipment.}$$

The above equation assumes that no freight will be carried on the return load. If the maximum truck cargo loading is designated by W_M , the range of W for the equation will be

$$0 < W \leq W_M.$$

The equation of total private fleet gain will be the common-carrier cost minus the private fleet cost, but since the common-carrier cost was described by three different equations, the gain equation will also extend over three separate ranges.

$$\text{For } 100 \text{ lbs.} < W \leq \frac{R_C}{R_L}(M)$$

$$G = R_L(W) - 2(R_M)(D),$$

$$\text{for } \frac{R_C(M)}{R_L} \leq W \leq M$$

$$G = M(R_C) - 2(R_M)(D),$$

$$\text{and for } M \leq W < W_M$$

$$G = W(R_C) - 2(R_M)(D).$$

The solution for the break-even point may now be given. For the fictitious commodity used in the example of Fig. 10 it was known that all of the break-even points occurred at a weight less than $\frac{R_C(M)}{R_L}$ so that the equation of the lower range of weight will be used in the solution. Substituting the rates and costs for the 1000 mile trip into the gain equation, setting the gain equal to zero and solving for W results in

$$0 = R_L(W) - 2(R_M)(D)$$

$$0 = \$4.21(W) - 2(\$0.30)(1000)$$

$$W = 14,252 \text{ pounds.}$$

But in some cases, such as is indicated in Fig. 14, the break-even point occurs at a weight larger than the carload or truckload minimum weight. The gain equation for the highest of the three ranges is used for the calculation of the break-even point for a situation such as this.

Examination of Fig. 10 will show that the minimum carload weight strongly affects the break-even points and the private fleet gain for the commodity in question. This relationship of minimum carload weight is shown more clearly in Fig. 14. This figure shows the total shipment cost for a specific commodity--"sinks, metal or metal and wood combined,

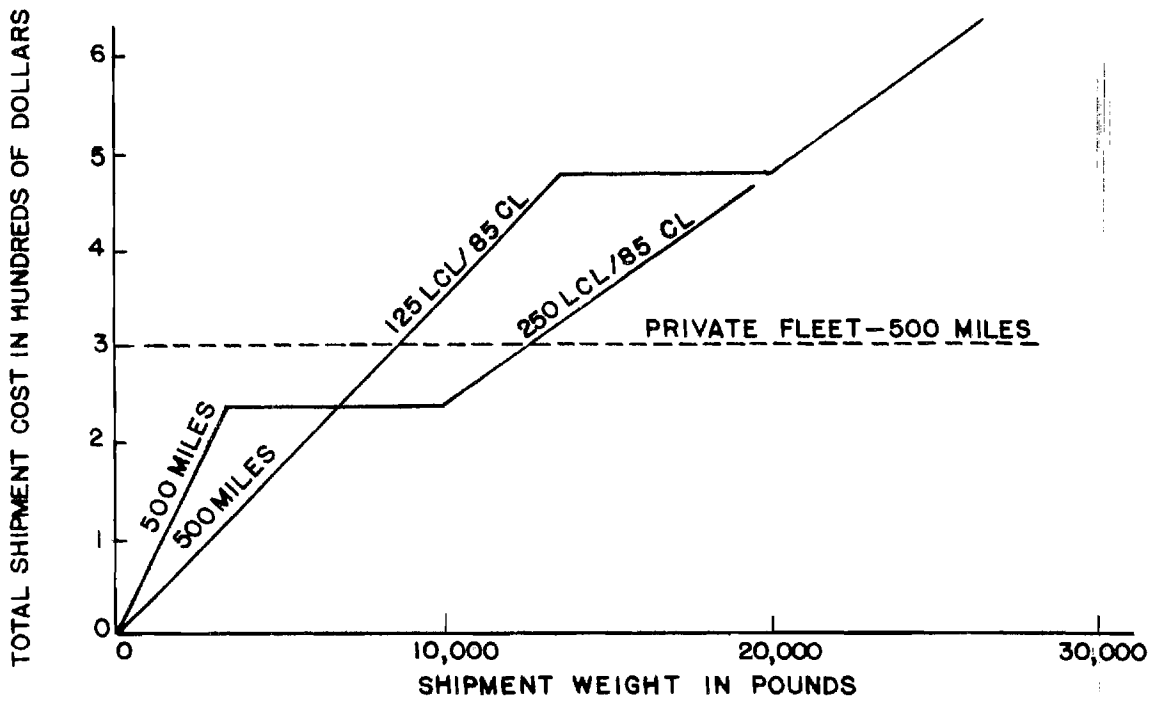


FIGURE 14A

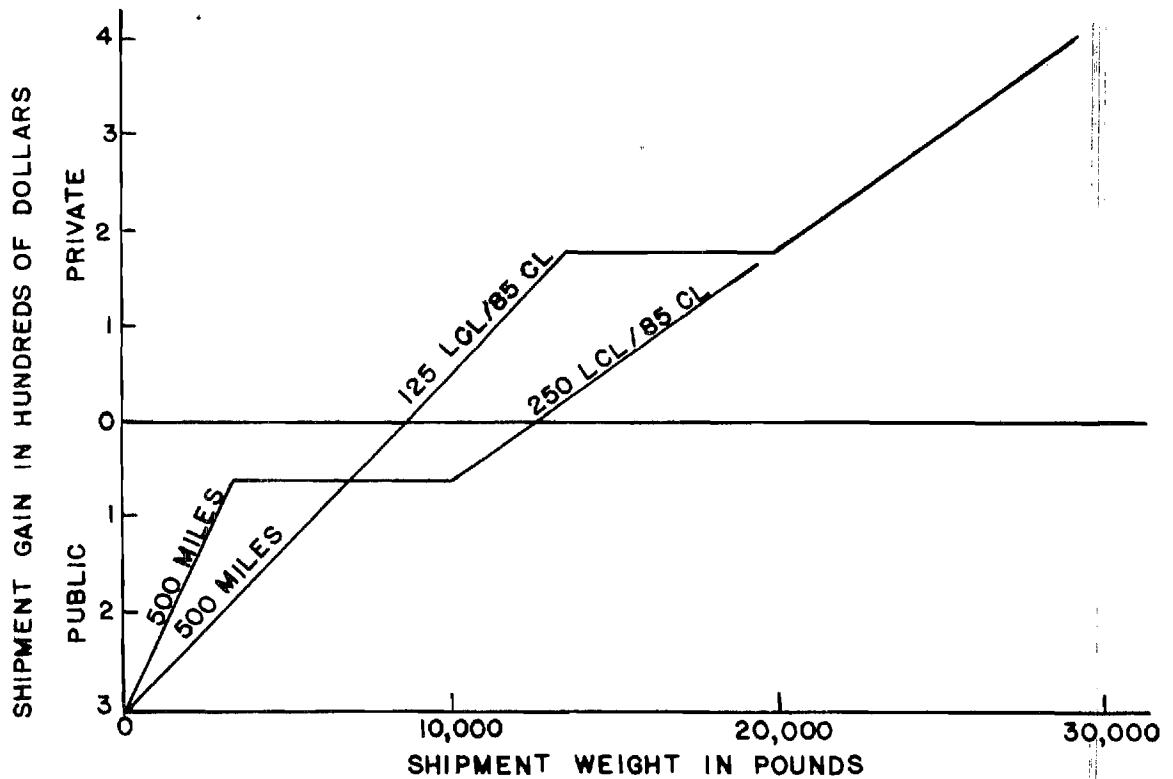


FIGURE 14B

EFFECT OF MINIMUM CARLOAD WEIGHT ON GAIN

with legs in place, loose".⁸ The classification shows for these articles a LCL rating of 250, a CL rating of 85, and a truckload minimum weight of 10,000 pounds; calculations show that the truckload rate would take effect at 3,400 pounds. Figure 14 indicates that for a shipment distance of 500 miles the break-even point for total shipment gain is about 12,500 pounds. This weight is high considering the bulkiness of the articles and the fact that the weight is 125 per cent of the truckload minimum weight. Consider for the sake of illustration only that the LCL rating for the sinks has been reduced to one half of its original value and that the truckload minimum weight has been increased to twice its original value. The shipment cost and shipment gain for these conditions are plotted in Fig. 14. It will be noticed that the break-even point now occurs in the less-than-truckload portion of the curve at a weight of about 8,500 pounds and that the gain is substantially greater than for the original classification at all shipment weights. This example shows that the rating is not the only important consideration in comparing the costs of private and purchased freight transportation costs. The value of the total shipment gain curves is enhanced by the example because the effect of the minimum truckload weight on the total shipment gain is hard to visualize without a graphic representation.

The decision of whether to route a shipment by common carrier or by the private fleet can be segregated into two types. A Type-I routing situation will be one in which the number of trucks required to move the shipments that fall into the private-fleet-gain region of the total shipment gain curve exceeds the number of the trucks available. The case in

⁸ American Trucking Association, Inc., National Motor Freight Classification, A-3 (Washington: April 1, 1956), p. 236.

which the number of available trucks exceeds the number of trucks needed to transfer the shipments which indicate private fleet gain will be classified as Type II. When the available trucks exceeds the total truck requirements of all outgoing shipments and every one of the shipments show a private fleet gain, this case will be an exception to the rules stated above; the situation will be classified as Type I.

The basic problem in a Type I situation is to find the shipments which show the least private fleet gain and offer them to a suitable common carrier since the company's trucks cannot haul all of the "good" freight available. The shipments which were found to have public transportation gain, if there were any, would of course be given to common carriers also. In the case of the exception to Type I all of the shipments were ones with private fleet gain and all of the trucks were not needed to move the shipments. There is no problem here because the fleet would carry all the shipments, and the extra trucks would just have to remain idle.

The Type II situation is not as simple. In this case it was found that after selecting the shipments with private fleet gain, there were still trucks available for use and public-transportation-gain shipments to route. The question to be answered is then whether it is better to let the trucks remain idle while common carriers are allowed to transfer all of the public-transportation-gain freight or to use the trucks for these shipments at an apparent loss. The answer to the question lies in the understanding of fixed and variable components of the normal truck mileage rate. It must be remembered that the fixed costs and the fixed component of the semi-fixed cost for private truck fleets continue to

accrue even though the trucks are not operating. On the other hand, the variable costs and the variable component of the semi-fixed costs increase only when the fleet mileage increases.

If the trucks are operated to move the public-transportation-gain shipments instead of remaining idle, the additional cost to the company for the use of the trucks is the amount of the variable costs. This conclusion is arrived at by subtracting the cost of not operating the trucks, the fixed cost, from the cost of operating them under normal conditions, the total cost. The difference, the variable cost, is the expense of the private fleet which should be used in the comparison of private fleet costs and purchased transportation costs in the Type II situation.

This reasoning parallels the practice of economic dumping and multiple-price policy for consumer goods. When the management of a company finds that there are no longer any substantial sales possibilities with one of its products even with a reduction in price, the decision may be made to "dump" their product on the foreign market. The product can be sold at a price which is somewhere between the variable expense and the total expense of manufacturing the product. Even by selling the product at a price lower than the full cost of manufacturing it, the company utilizes its plant's excess capacity and apportions some of its fixed costs to the goods which are sold on the foreign market and thereby increases the company's profit.

Another form of dumping practiced by manufacturers of consumer goods is to sell their product under two brand names. The products sold under the first-rate brand name are priced above the total cost of manufacturing the goods. The articles carrying the second-rate brand name,

which may be the same as the articles with the first-rate name or of some lower quality, are sold at a lower price. The price for these goods may even be less than the full cost to manufacture the articles, but still the total profit to the company is raised because of the utilization of idle capacity which might not have otherwise been used. As long as the price of the articles exceeds the variable manufacturing costs, some part of the fixed costs is being apportioned to the price of the goods. The theory of this practice is that only a certain number of the articles can be sold at the higher price, but if the price is reduced the sales will increase.

The shift in the normal truck mileage cost from the total cost to the variable cost when a Type II routing situation exists serves the same purpose as placing products on the foreign market at reduced prices or using lower prices for articles with second-rate brand names. However, the use of the variable cost for private fleet freight pricing can only be used when the trucks would otherwise be idle.

CHAPTER V

CONCLUSIONS

One of the primary objectives of this study has been to show that some of the principles and theories which have been developed and used so effectively in the field of manufacturing economics can also be applied to a problem in the field of transportation. The thesis has also been an attempt to show that freight costs can be analyzed in the general case and that general principles, relationships, and theories can be applied to a specific problem; the study of transportation rates and charges need not necessarily be confined to special, one-case examples. There seems to be a consensus among personnel in the transportation industry that there are too many factors involved in freight costs to state any general rule which is not specifically listed in an applicable tariff. It is true that the field is necessarily muddled with article exceptions, joint rates, commodity rates, carrier exceptions, governmental regulation and legislation, and so forth, but there are undoubtedly areas in which general principles can be applied with due caution and reserve. Lastly, it was desired by the writer to attempt to show that the scientific, engineering approach could be useful in transportation.

In the previous chapters there have been presented the development of graphic representation of three basic freight cost functions-- the common-carrier freight cost, the private-carrier freight cost, and private fleet gain which results when private trucks are used instead of common carriers. With these curves showing cost relationships, the magnitude of the factors which affect these costs can be visualized ~~and~~

more quickly and easily. The number of factors which affect these cost relationships are many, and for this reason the graphic treatment takes on greater significance. Although the details of the manner in which these costs curves can be used in actual practice was not given in the thesis, the areas of possible utility have been suggested.

The factors which affect the common carrier rate and the total cost curves for class-rate commodities are: (1) less-than-carload classification rating, (2) the carload classification rating, (3) the distance of the shipment, (4) weight of the shipment, and (5) the minimum carload weight. Private-fleet freight costs are affected by these factors: (1) fixed costs, (2) semi-fixed cost, (3) variable costs, (4) mileage that the fleet is used during an unit time period, (5) distance of the shipment, (6) weight of the shipment, (7) weight of return load, if any, (8) the distance the truck travels empty to pickup the return load, and (9) the terminal, handling, and administrative costs. The private fleet gain would naturally be affected by a combination of the factors of both common carrier cost and private carrier costs.

Since each class of commodities has its own values for the factors of cost, it can be seen that the total number of combinations of factors which affect the transfer of a great many commodities by a company multiply very quickly. The greater the number of factors in the gain computation, the greater will be the difficulties in the practical application of the gain curves. It would then seem that the type of industry which could use the gain curves to the greatest advantage would be one which manufactured only one product from a few raw materials and shipped the finished product to consumers in only a few locations. A large mail-order distribution company shipping thousands

of types of articles to many destinations would find difficulty in maintaining a gain curve for each of its commodities, and would therefore obtain little or no utility in the type of analysis given in this thesis.

In the analysis given in the thesis the writer has arbitrarily assumed that the freight was all governed by class rates. The exception rates and commodity rates were omitted for the sake of simplicity, but the principles presented for use with class rates could just as well be applied to commodity or exception rates. Since the actual application of the gain curves must be adjusted to specific commodities for specific companies, the inclusion of specific rates such as exception rates presents no special problems.

The variation in the rate per unit weight of private fleet transportation has implications for the determination of economic order sizes. Even with freight transfer by common carriers the rate is not constant as is shown by Fig. 2. The fact that the transportation rate decreases as the shipment weight increases would tend to increase the size of the optimum order. The freight cost factors should be included in the company's lot-size analysis, especially when the cost of transportation is a large percentage of the raw material cost.

This study has emphasized the use of the private fleet gain curves in determining which shipment should be hauled by the truck fleet and which should be routed by common carrier. However, there are two other major problems of concern to industrial traffic management in relation to private fleets. One of these problems is the projected freight cost analysis necessary to make the decision about acquiring a private fleet. The gain curves could aid in this type of problem in giving the estimated

saving which the fleet would bring to the company. The second important problem of private fleet operation is the determination of the optimum size of fleet and the relative advantages of buying or leasing the fleet. These two problems constitute possible areas for further research.

A P P E N D I X

Table 1. Railroad and Motor Carrier Class-100 Rates

Inclusive Mileage	Rail ⁹ Rate (cents per hundredweight)	Motor ¹⁰ Rate (cents per hundredweight)
1 to 5	not listed	71
6 to 10	78	78
11 to 15	84	84
16 to 20	89	89
21 to 25	92	92
26 to 30	98	98
31 to 35	101	101
36 to 40	105	105
41 to 45	107	108
46 to 50	111	111
51 to 55	114	114
56 to 60	117	117
61 to 65	121	121
66 to 70	123	123
71 to 75	125	125
76 to 80	129	129
81 to 85	131	131
86 to 90	135	135
91 to 95	137	137
96 to 100	139	139
101 to 110	144	144
111 to 120	148	148
121 to 130	154	154
131 to 140	157	157
141 to 150	162	162
151 to 160	165	165
161 to 170	171	171
171 to 180	174	174
181 to 190	178	178
191 to 200	181	181
201 to 210	187	187
211 to 220	190	190
221 to 230	194	194
231 to 240	197	197
241 to 260	205	205

⁹Southern Freight Tariff Bureau, Agent, Freight Tariff No. S-1011 ..., Supplement No. 49, (Atlanta, July 13, 1956).

¹⁰Southern Motor Carrier's Rate Conference, Agent, Freight Tariff No. 501 ..., Supplement No. 101, (Atlanta, August 20, 1956).

Table 1. Railroad and Motor Carrier Class-100 Rates

(continued)

Inclusive Mileage	Rail Rate (cents per hundredweight)	Motor Rate (cents per hundredweight)
261 to 280	211	211
281 to 300	218	218
301 to 320	226	226
321 to 340	232	232
341 to 360	239	239
361 to 380	245	245
381 to 400	251	251
401 to 420	258	258
421 to 440	263	263
441 to 460	269	269
461 to 480	276	276
481 to 500	282	282
501 to 520	287	287
521 to 540	294	294
541 to 560	299	299
561 to 580	305	305
581 to 600	311	311
601 to 620	317	317
621 to 640	323	323
641 to 660	330	330
661 to 680	335	335
681 to 700	341	341
701 to 720	348	348
721 to 740	354	354
741 to 760	359	359
761 to 780	366	366
781 to 800	372	372
801 to 825	378	378
826 to 850	384	384
851 to 875	390	390
876 to 900	396	396
901 to 925	403	403
926 to 950	408	408
951 to 975	414	414
976 to 1000	421	421
1001 to 1025	427	427
1026 to 1050	433	432
1051 to 1075	439	439
1076 to 1100	445	445
1101 to 1125	452	452

Table 1. Railroad and Motor Carrier Class-100 Rates
(continued)

Inclusive Mileage	Rail Rate (cents per hundredweight)	Motor Rate (cents per hundredweight)
1126 to 1150	457	457
1151 to 1175	463	462
1176 to 1200	470	470
1201 to 1225	476	476
1226 to 1250	481	481
1251 to 1275	488	488
1276 to 1300	494	494
1301 to 1325	500	500
1326 to 1350	506	506
1351 to 1375	512	512
1376 to 1400	518	518
1401 to 1425	525	525
1426 to 1450	530	530
1451 to 1475	536	536
1476 to 1500	543	543

Note: The rail rates given in the table are corrected to include all increases up to and including Ex Parte 196, and the motor rates listed include increases granted under Ex Parte 175.

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